

GAO

Report to Congressional Committees

April 2000

# UNMANNED AERIAL VEHICLES

## Progress of the Global Hawk Advanced Concept Technology Demonstration



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United States General Accounting Office  
Washington, D.C. 20548

National Security and  
International Affairs Division

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Congressional Committees

The Department of Defense (DOD) has built five prototype Global Hawk reconnaissance aircraft for use in a High Altitude Endurance Unmanned Aerial Vehicle Advanced Concept Technology Demonstration.<sup>1</sup> The Advanced Concept Technology Demonstration's purpose is to determine through design and construction of Global Hawk prototypes, and a subsequent assessment of their utility in military user demonstrations, if the concept is effective as an Air Force reconnaissance aircraft before DOD decides whether to acquire a production version of it. Reconnaissance aircraft such as Global Hawk are used to obtain information about the activities and resources of enemy forces.

If DOD decides to acquire Global Hawk, the production version is expected to provide the Air Force with the ability to fly for 40 continuous hours and conduct reconnaissance for up to 24 hours at a radius of 3,000 nautical miles. In 1994, when the Advanced Concept Technology Demonstration was initiated, DOD established a \$10-million average unit flyaway price goal in fiscal year 1994 dollars for air vehicles numbered 11 through 20.<sup>2</sup> The unit flyaway price covers the cost of the vehicle, its reconnaissance sensors, and the contractor's fee. Unit flyaway price excludes costs for systems engineering and program management, system test and evaluation and non-recurring tooling, engineering and manufacturing development, and non-flying support equipment such as the ground control station.

Because of concerns about Global Hawk's affordability, Congress directed us to review the Global Hawk Advanced Concept Technology

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<sup>1</sup>Advanced Concept Technology Demonstrations do not follow DOD's formal approval process for its acquisition programs. Instead, before a formal decision to acquire a product is made, a given mature technology is demonstrated to military commanders who determine if the technology has military application, and is cost-effective.

<sup>2</sup>In accordance with DOD's agreement with the Global Hawk contractor, the first 10 production aircraft were to be Global Hawk aircraft numbered 11 through 20. Aircraft numbered 1 through 10 were to be prototypes for the demonstration. However, to save money, only five demonstration prototypes were built.

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Demonstration.<sup>3</sup> Our objectives were to determine (1) whether the average unit flyaway price for the 10 Global Hawk production aircraft numbered 11 through 20 will be within DOD's price goal of \$10 million each in fiscal year 1994 dollars; (2) the status of the military user demonstration, including the extent to which Global Hawk has demonstrated reconnaissance capabilities; and (3) DOD and Air Force plans to transition to a formal acquisition program. This is our second report addressing the status of DOD's progress toward meeting its price goal for Global Hawk.<sup>4</sup> In our prior report, we concluded that DOD was not making progress toward the goal.

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## Results in Brief

The Global Hawk Advanced Concept Technology Demonstration has made progress in terms of achieving performance objectives, but has not made progress toward the price goal. Neither DOD nor the Global Hawk contractor expects to achieve the \$10 million average unit flyaway price goal for the 10 production air vehicles numbered 11 through 20. The most recent projection from the contractor in July 1999 is an average unit flyaway price of \$15.3 million in fiscal year 1994 dollars. The \$15.3 million unit price represents an increase of \$0.5 million per unit from DOD's July 1998 estimate of \$14.8 million per unit. The contractor's projection is based on data from actual costs incurred for construction of the third prototype built, assumes there will not be significant design changes to the prototype aircraft, and assumes higher annual production rates than DOD is now planning. Moreover, the Air Force, which manages the Global Hawk Advanced Concept Technology Demonstration, has not finalized its design requirements for a future production version or completed an analysis to determine the total number of Global Hawks it needs. Although the Air Force expects to address these issues before the Advanced Concept Technology Demonstration is complete in September 2000, based on a set of draft minimum requirements the Air Force is considering adopting, the actual average unit flyaway price paid by DOD in the future for the production version could be significantly higher than \$15.3 million.

To assess whether Global Hawk has military utility, the Air Force began demonstrating the prototype aircraft in June 1999 for military users and

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<sup>3</sup>National Defense Authorization Act for Fiscal Year 1998, section 216.

<sup>4</sup>*Unmanned Aerial Vehicles: Progress Toward Meeting High Altitude Endurance Aircraft Price Goals* (GAO/NSIAD-99-29, Dec. 15, 1998).

their assessment is ongoing.<sup>5</sup> To date, the Global Hawk prototype has demonstrated basic flying capabilities but has not yet undergone sufficient testing to determine whether it can successfully conduct reconnaissance missions on a regular basis. According to an October 1999 test report from the Air Force, the prototype has flown at altitudes in excess of 66,000 feet and for lengths of more than 27 hours. However, of the 1,200 flight-test hours planned for the user demonstrations, only about 260 were completed by the end of January 2000. DOD plans to increase the number of flight-test hours dedicated to demonstrating reconnaissance capability before the flight-test phase is complete in June 2000. According to DOD, while fewer hours have been dedicated to testing reconnaissance sensors, the sensors' different operating modes have been tested, and over 2,700 recorded images have been transmitted to military users to assess the aircraft's reconnaissance capability.

Although the Air Force had hoped to secure an early decision to proceed with the acquisition of Global Hawk in July 1999, DOD delayed a formal decision on whether to acquire it until September 2000 after the Advanced Concept Technology Demonstration, including the user demonstration and assessment, is complete. In the meantime, at DOD's request, Congress has authorized the Air Force to procure the sixth and seventh prototype air vehicles to sustain the Global Hawk industrial base. DOD's decision to wait for the conclusion of the Advanced Concept Technology Demonstration before committing to formally acquire Global Hawk is prudent because by September 2000, a number of important unknowns will be addressed. These include the Air Force's final requirements for a production version of Global Hawk, determination of how many Global Hawks the Air Force may need, and analyses of the user demonstration and assessment results and cost data from the Advanced Concept Technology Demonstration. Eliminating these unknowns before an acquisition decision is consistent with the best practices of leading commercial firms. These firms do not commit to produce a new product until knowledge about technological maturity and cost-effectiveness is available.<sup>6</sup>

<sup>5</sup>During the military utility assessment, the Air Force is operationally demonstrating the Global Hawk prototype's capabilities during military exercises in realistic operational environments so that military users can assess its mission effectiveness.

<sup>6</sup>*Best Practices: Successful Application to Weapon Acquisitions Requires Changes in DOD's Environment* (GAO/NSIAD-98-56, Feb. 24, 1998).

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## Background

In 1994, DOD began the Global Hawk Advanced Concept Technology Demonstration as one of a number of advanced concept technology demonstrations. As an Advanced Concept Technology Demonstration, Global Hawk does not follow DOD's formal approval process for acquisition programs. Rather, through the use of prototypes, a mature technology is field tested by military users to determine whether there is an effective military application. Based on the results of the Advanced Concept Technology Demonstration, a decision is made whether to transition the demonstration product into a formal acquisition program. DOD's original manager for the effort, the Defense Advanced Research Projects Agency, and Global Hawk's prime contractor, Northrop-Grumman's Ryan Aeronautical Center, envisioned Global Hawk to be an affordable way to augment the Air Force's manned U-2 high altitude reconnaissance aircraft. The Air Force assumed program management responsibility for the Advanced Concept Technology Demonstration in October 1998.

Global Hawk is a large aircraft measuring longer than 40 feet with a wingspan of more than 100 feet. (See fig. 1.) During the Global Hawk Advanced Concept Technology Demonstration, the contractor has built five prototypes. The fifth prototype was delivered to DOD in November 1999. One of the vehicles was destroyed when it crashed in March 1999. This crash delayed the start of the Air Force's user demonstration from April until mid-June 1999. DOD expects to make a formal acquisition decision in September 2000.

**Figure 1: Global Hawk High Altitude Endurance Unmanned Aerial Vehicle**

Source: U.S. Air Force.

## DOD and Contractor Do Not Expect Global Hawk to Achieve Price Goal

Neither Global Hawk's prime contractor nor DOD expects to achieve the \$10-million average unit flyaway price goal in fiscal year 1994 dollars. The price goal was established by agreement between DOD and the contractor and was to be applicable to the 10 production air vehicles numbered 11 through 20 should DOD proceed with a formal acquisition program after the Advanced Concept Technology Demonstration. The contractor's most recent average unit flyaway price projection (dated July 1999) is \$15.3 million in fiscal year 1994 dollars. The contractor's projection is based on data from actual costs incurred for construction of the third prototype, assumes there will not be significant design changes between the prototype aircraft and the aircraft built in a future production phase, and assumes higher annual production rates than DOD is now planning. The \$15.3-million unit price projection also represents an increase of \$0.5 million per unit from DOD's unit price projection of \$14.8 million made in July 1998. A comparison of these projections to the original goal is shown in table 1.

**Table 1: 1994, 1998, and 1999 Average Unit Flyaway Price Projections for Production Air Vehicles Numbered 11 Through 20**

Fiscal year 1994 millions of dollars

Category	Contractor projection (1994) <sup>a</sup>	DOD projection (July 1998)	Contractor projection (July 1999)
Structure	\$2.6	\$6.1	\$6.1
Avionics	0.4	0.5	0.6
Sensors	4.1	5.2	6.7
Propulsion	1.6	1.6	1.9
Fee	1.3	1.4	<sup>b</sup>
<b>Total</b>	<b>\$10.0</b>	<b>\$14.8</b>	<b>\$15.3</b>

<sup>a</sup>Projections assume production aircraft will not differ significantly from prototype aircraft.

<sup>b</sup>For its July 1999 projection, the contractor did not show its fee separately. Rather, a 12-percent fee is included in component subtotals.

Sources: DOD and Northrop-Grumman Ryan Aeronautical Center.

According to DOD, most of the \$5.3-million overall increase since 1994 in the projected average flyaway price for Global Hawk is due to the need to achieve the aircraft's range and endurance objectives. This required the contractor to modify the wings and other structural parts, adding a projected \$3.5 million to the structural cost of each aircraft. The second largest projected increase is in the price of the electro-optical, infrared, and synthetic aperture radar reconnaissance sensors selected by the contractor.<sup>7</sup> The contractor's original projection of \$4.1 million per aircraft for these reconnaissance sensors was a significant underestimate compared with its July 1999 projection of \$6.7 million per aircraft. Further, the contractor's July 1999 \$15.3 million unit price projection includes the effects of two factors that were not considered in developing the 1994 projection. First, breaks in construction between the second and third prototypes, and after the fifth prototype, prevented the contractor from

<sup>7</sup>The aircraft's sensors are used by the aircraft's operators on the ground to make images of what is below the aircraft for analysis.

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reducing costs per aircraft as rapidly as anticipated.<sup>8</sup> The second factor is DOD's lower planned annual production rate of 2 per year versus the original plan to acquire 10 Global Hawk production aircraft in a single year. This reduced the contractor's plans to achieve unit cost savings through greater economies of scale.

The Air Force and the contractor continue to collect actual cost data for use in updating their projections of average unit flyaway price. Continuing to collect and update this knowledge until the end of the Advanced Concept Technology Demonstration in September 2000 is important because it will form the basis for determining Global Hawk's cost-effectiveness. In addition, the actual average unit flyaway price paid by DOD in the future for the production version could differ significantly from \$15.3 million because the Air Force has not finalized its design requirements for a future production version or completed an analysis of alternatives to determine how many Global Hawks it will need.

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**Unit Price May Change  
Once Operational  
Requirements Are Finalized**

Concurrent with the ongoing Advanced Concept Technology Demonstration, the Air Force is preparing an operational requirements document for Global Hawk. This document will formally identify all the performance capabilities that the Air Force will require for Global Hawk to be considered ready to operationally deploy successfully. The Air Force expects to complete this document by September 2000.

During the requirements generation process, the Air Force expects to use affordability as a factor in prioritizing Global Hawk performance requirements. For example, according to a draft Air Force operational requirements document, improvements to current Global Hawk prototype reconnaissance sensors must be funded. Conversely, active defensive systems to protect Global Hawk from missiles (e.g., a towed decoy capability), though included in the contractor's design, are identified as lower priority objectives to be included in production when funding becomes available. Improved sensors would increase the average unit flyaway price by \$700,000. Not requiring defensive systems would lower it by \$600,000. A more precise and comprehensive estimate on the impact to

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<sup>8</sup>A "break in construction" occurs when a manufacturing process comes to a stop. In this case, DOD did not immediately authorize the contractor to begin building the third or sixth prototypes when it was ready to do so and work ceased. The subsequent disruption to the continuity of the work, according to the Global Hawk contractor, caused its employees to not become as efficient at building Global Hawks as it projected they would.



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the average unit flyaway price can be made once the operational requirements document is approved in September 2000.

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### Analysis of Alternatives for Reconnaissance Aircraft Is Ongoing

Another key program document that is currently being drafted by the Air Force is an Analysis of Alternatives evaluating other approaches to performing the mission the Global Hawk is being designed to perform. The primary alternative being evaluated is the purchase of additional U-2 manned reconnaissance aircraft. The Air Force expects to publish this document in April 2000. The outcome of this analysis could further affect Global Hawk's average unit flyaway price by influencing the total number of Global Hawks the Air Force concludes it may need.

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### Global Hawk Military Utility Assessment Is Progressing

The Global Hawk Advanced Concept Technology Demonstration, including ongoing user demonstrations and the military utility assessment, is to be completed by September 2000. During the user demonstrations, Global Hawk prototypes are being flown in military exercises so military users can assess their usefulness as high-altitude, endurance reconnaissance aircraft. The prototype was originally expected to fly to altitudes greater than 65,000 feet and spend 40 hours aloft. An October 1999 report concludes that the prototype has successfully demonstrated basic flying capabilities, reaching altitudes in excess of 66,000 feet and flying for lengths of more than 27 hours.<sup>9</sup> On one assessment flight, a Global Hawk successfully flew over a large section of the western United States, encompassing California, Nevada, Idaho, and Utah, while being controlled from a ground station in California.

However, while the assessment plan calls for flying 1,200 hours between June 1999 and June 2000, only about 260 hours had been flown as of January 2000. Additionally, Air Force testers noted that of the hours flown, only a limited number have been dedicated to demonstrating the aircraft's sensors can successfully complete the reconnaissance mission. DOD plans to address this by increasing the number of test hours dedicated to demonstrating reconnaissance capability as the assessment proceeds. Furthermore, according to DOD, though flight hours flown in support of sensor demonstrations are lower than anticipated, all of the aircraft's sensor modes have been successfully evaluated, and over 2,700 recorded

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<sup>9</sup>Global Hawk Quick Look Report, U.S. Air Force, October 1999.

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images have been distributed to assessment participants for analysis. Future reports should provide a better indication of Global Hawk's military usefulness. This information, together with the cost data, will allow DOD to make an informed tradeoff between cost and technical performance as part of the decision whether to transition to a formal acquisition program and proceed with production.

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### Acquisition Decision Delayed Until Completion of Advanced Concept Technology Demonstration

Although the Air Force had hoped to secure in July 1999 an early decision to proceed with the acquisition of Global Hawk, DOD delayed a formal decision on whether to acquire it until after the Advanced Concept Technology Demonstration is complete in September 2000. In the meantime, an Intelligence Program Decision Memorandum issued in August 1999 directed the Air Force to add funding to initiate an acquisition program with an expected acquisition decision for engineering and manufacturing development at the end of fiscal year 2000. DOD's decision to wait is prudent because by September 2000, the actual costs incurred to build the first five aircraft, the operational requirements document, the analysis of alternatives, and the Global Hawk user demonstration and military utility assessment results should be available for use in deciding whether to formally acquire Global Hawk.

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### Air Force Preparing for Transition to Production

Concurrent with the ongoing assessment, the Air Force has been preparing for the Global Hawk acquisition decision. To that end, in July 1999, the Air Force developed a number of acquisition strategy alternatives and presented them to the Under Secretary of Defense for Acquisition, Technology and Logistics. In response, the Under Secretary approved continuing activities to prepare for a transition to acquisition, including procuring a sixth and seventh aircraft of the prototype design to sustain the Global Hawk industrial base. However, he delayed a formal decision to proceed beyond the Advanced Concept Technology Demonstration until it is complete in September 2000.

The Under Secretary's decision to wait for the conclusion of the Advanced Concept Technology Demonstration before committing DOD to acquire Global Hawk is prudent because there are still a number of important unknowns that need to be addressed. These include the actual costs incurred to build the first five aircraft, the operational requirements document, the analysis of alternatives, and the Global Hawk user demonstrations and military utility assessment results. Our work in the best practices area shows leading commercial firms do not commit to

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produce a new product until knowledge about technological maturity and cost-effectiveness is available. Product development is thereafter a clearly defined undertaking to design and manufacture an end item for delivery to a customer that the customer needs and can afford.

If a decision to acquire Global Hawk is made in September 2000, the Air Force's preferred acquisition strategy would begin with an engineering and manufacturing development phase before production. According to the Air Force, the objective of the proposed development phase would be to make design changes to improve the prototype Global Hawk so the production version will be operationally ready to be deployed. As directed by the Defense Acquisition Executive, this 1-year engineering and manufacturing development phase would begin in fiscal year 2001 and is estimated to cost \$87.4 million.

As part of the 1-year engineering and manufacturing development phase, the Air Force would complete the two additional Advanced Concept Technology Demonstration prototype aircraft requested by DOD and approved by Congress while preparing to produce the improved aircraft. Following this engineering and manufacturing development phase, the Air Force will begin initial production of eight of the improved aircraft (and two ground control stations) from fiscal years 2002 through 2005. The total cost of procurement planned during this phase is \$365.6 million. The total estimated cost of the overall program implementing the Air Force's preferred acquisition strategy for Global Hawk would be \$772.9 million, as shown in table 2.

**Table 2: Estimated Cost to Improve Global Hawk and Procure Improved Production Versions (Preferred Air Force Acquisition Strategy)**

Major cost category	Estimated cost in then-year millions of dollars, fiscal years 2001-05
Research, Development, Test, and Evaluation	\$306.3 <sup>a</sup>
Procurement (includes 8 improved aircraft and 2 ground stations)	365.6 <sup>b</sup>
Operations and maintenance	51.0
Military construction	50.0
<b>Total</b>	<b>\$772.9</b>

<sup>a</sup>This figure includes funding for procuring the 2 additional, congressionally approved, prototype air vehicles in fiscal year 2001, the 1-year engineering and manufacturing development period in fiscal year 2001 to improve the prototype design, and funding for further development in fiscal years 2002-2005 for a future Global Hawk aircraft with more improvements.

<sup>b</sup>This figure includes procurement of all equipment necessary to operate Global Hawk, not just the aircraft.

Source: U.S. Air Force.

## Agency Comments

DOD provided written comments on a draft of this report (see app. I). DOD generally concurred with the report and suggested technical changes for clarification and accuracy that we incorporated as appropriate.

## Scope and Methodology

To determine DOD's progress toward meeting its price goal, the status of the user demonstrations, and DOD and the Air Force's acquisition plans, we met with DOD, Air Force, and contractor officials, and analyzed Global Hawk cost data, an assessment report, draft requirements documents, and program plans. We conducted our work at the Division of Intelligence, Surveillance, and Reconnaissance Systems, Office of the Secretary of Defense, Washington D.C; Air Combat Command and U.S. Atlantic Command (now Joint Forces Command), Norfolk, Virginia; the Air Force Reconnaissance System Program Office, Wright-Patterson Air Force Base, Ohio; and Ryan Aeronautical Center, Northrop-Grumman Corporation.

We conducted our work from January 1999 through January 2000 in accordance with generally accepted government auditing standards.

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We are sending copies of this report to the Secretaries of Defense and the Air Force, and the Director of the Office of Management and Budget. We will also provide copies to others upon request. If you or your staff have any questions, please contact me at (202) 512-4841. Principal contributors to this report were Charles Ward, Richard Strittmatter, and Michael McGuire.

A handwritten signature in black ink, reading "Louis J. Rodrigues". The signature is written in a cursive style with a large, looping initial "L".

Louis J. Rodrigues  
Director, Defense Acquisitions Issues

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List of Congressional Committees

The Honorable John Warner  
Chairman  
The Honorable Carl Levin  
Ranking Minority Member  
Committee on Armed Services  
United States Senate

The Honorable Richard C. Shelby  
Chairman  
The Honorable Robert Kerrey  
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# Comments From the Department of Defense



COMMAND, CONTROL,  
COMMUNICATIONS, AND  
INTELLIGENCE

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE  
6000 DEFENSE PENTAGON  
WASHINGTON, DC 20301-6000

March 20, 2000

Mr. Louis J. Rodrigues  
Director, Defense Acquisition Issues  
National Security and International  
Affairs Division  
U.S. General Accounting Office  
Washington, D.C. 20548

Dear Mr. Rodrigues:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "UNMANNED AERIAL VEHICLES: Progress of Global Hawk Demonstration Effort," dated February 17, 2000 (GAO Code 707385/OSD Case 1948).

The DoD has reviewed the draft report and generally concurs. Suggested technical changes for clarification and accuracy have been provided separately.

The Department appreciates the opportunity to comment on the draft report. For further questions concerning this report, please contact Mr. Ash Lafferty, ISR Systems, 703-695-3359.

Sincerely,

Robert M. Nutwell, RADM, USN  
Deputy Assistant Secretary of Defense  
(C3ISR and Space Systems)